

S/N unknown

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant: SHIRAISHI et al. Serial No.: unknown
Filed: concurrent herewith Docket No.: 10873.867US01
Title: PIEZOCOMPOSITE, ULTRASONIC PROBE FOR ULTRASONIC
DIAGNOSTIC EQUIPMENT, ULTRASONIC DIAGNOSTIC EQUIPMENT,
AND METHOD FOR PRODUCING PIEZOCOMPOSITE

CERTIFICATE UNDER 37 CFR 1.10

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Date of Deposit: January 22, 2002

I hereby certify that this correspondence is being deposited with the United States Postal Service 'Express Mail Post Office To Addressee' service under 37 CFR 1.10 on the date indicated above and is addressed to the Assistant Commissioner for Patents, Washington, D.C. 20231.

By: 

Name: Chris Stordahl

PRELIMINARY AMENDMENT

Assistant Commissioner for Patents
Washington, D.C. 20231

Dear Sir:

In connection with the above-identified application filed herewith, please enter the following preliminary amendment (marked-up copy attached):

IN THE SPECIFICATION

Please replace the consecutive paragraphs, beginning on page 18, line 6, with the following:

As a step of applying a paste containing a piezoelectric powder and a binder to the grooves 11, a paste composed of a piezoelectric powder, a binder, and a solvent was applied over the grooves 11 on the substrate 1 so as to fill the grooves 11, then, unnecessary paste portions 2 outside the grooves 11 were removed. As a result, the substrate 1 in which the paste was applied to only the inside of each groove 11 was obtained, as shown in the schematic perspective view of

FIG. 2A and the schematic cross-sectional view of FIG. 2B. Though not particularly limited, a conventional technique of a thick film material can be applied for forming the paste. For instance, a paste obtained by adding 10 cc of an α -terpineol (reagent manufactured by Wako Pure Chemical Industries, Ltd.) solution containing 6 wt% of ethyl cellulose 45 cP (manufactured by Kanto Kagaku) as a binder to 40 g of a piezoelectric powder of lead titanate zirconate (PZT) or the like and kneading the same using a three roll mill can be used. Subsequently, on the groove-provided surface of the groove-provided magnesium oxide plate as the substrate 1, the PZT paste as the paste was applied and squeezed by a rubber squeegee so as to fill the grooves with the PZT paste while removing unnecessary portions of the PZT paste from outside the grooves. Alternatively, to fill the grooves 11 with the paste sufficiently, air bubbles contained therein preferably were removed by depressurizing or vibrating with ultrasonic waves after applying the paste in the grooves 11.

(3) Step of drying the coating films

As a step of drying the coating films, the solvent component was dried and removed from the paste provided in the grooves 11 of the substrate 1. As a method for drying the solvent, any method may be applied, such as natural drying, hot air drying, etc. Besides, according to a quantity to be treated, the batch manner or the continuous manner may be selected. In the present embodiment, the solvent component in the PZT paste was removed by drying the same at 100°C in a hot air circulating batch-type dryer for 5 minutes.

Please replace the paragraph, beginning on page 19, line 23, with the following:

Subsequently, the heat treatment was continued so that the temperature was raised to 1250°C during 12.5 hours and thereafter it was maintained at 1250°C for two hours, so that the

piezoelectric powder was sintered. By so doing, thin-line-form sinter pieces 3 were obtained on the substrate 1. The paste that had been dried and from which the binder had been removed was sintered in the grooves 11 of the substrate 1, thereby forming the thin-line-form sinter pieces 3. The thin-line-form sinter pieces 3 thus obtained were sintered in the state of being constrained and arranged in the grooves 11 formed in the substrate 1. Consequently, as shown in the schematic perspective view of FIG. 3A and the schematic cross-sectional view of FIG. 3B, a plurality of thin-line-form sinter pieces 3 were obtained on the substrate 1, arranged at intervals according to the intervals between the grooves 11 formed in the substrate 1. In the present embodiment, 200 thin-line-form sinter pieces, each having a width and a height of 0.065 mm each and a length of 30 mm, were obtained on the substrate 1. Furthermore, the thin-line-form sinter pieces 3 had a volume reduced to 65 % in average as compared with the volume in the material paste state. It should be noted that the steps (1) to (5) may be carried out at the same time.

Please replace the paragraph, beginning on page 25, line 26, with the following:

Then, a step (c), applied to the sintered piezoelectric plate provided with the resin layer, formed a plurality of parallel cut grooves without completely dividing the resin layer so as to cut the sintered piezoelectric plate into a plurality of sintered piezoelectric thin wires. 170 cut grooves, each having a width of 0.05 mm and a depth of 0.05 mm to 0.06 mm, were formed at intervals of 0.1 mm on the sintered piezoelectric plate having the foregoing resin layer, using a dicing machine. As a result, as shown in the schematic perspective view of FIG. 11, a composite sheet unit 50 was obtained that was composed of a resin layer 22 having a size of 17 mm in vertical length \times 17 mm in horizontal length \times 0.05 mm in thickness and 170 sintered

piezoelectric thin wires, each having a width of 0.05 mm, a thickness of 0.05 mm, and a length of 17 mm. 11 denotes a cut groove.

Please replace the paragraph, beginning on page 34, line 20, with the following:

(a) First of all, composite sheet units 50 were obtained by the same method as that described with regard to the fourth embodiment. Namely, each composite sheet unit prepared was a composite sheet unit 50 in which 170 sintered piezoelectric thin wires, each having a width of 0.05 mm, a thickness of 0.05 mm, and a length of 17 mm, were arranged on a resin layer 2 in a size of 17 mm in vertical length \times 17 mm in horizontal length \times 0.05 mm in thickness. Then, as shown in the schematic perspective view of FIG. 18A, an epoxy resin layer in a size of 17 mm in vertical length \times 17 mm in horizontal length \times 0.025 mm in thickness as a resin layer 22, or more specifically, an epoxy-base-resin adhesive sheet (Product No.: T2000 manufactured by Hitachi Chemical Co., Ltd.), in a size of 17 mm in vertical length \times 17 mm in horizontal length \times 0.025 mm in thickness, was laminated over the sintered piezoelectric thin wires 33 arranged on the composite sheet unit 50.

Please replace the paragraph, beginning on page 36, line 29, with the following:

(b) Two of the foregoing composite sheet units 50 were provided so that the sintered piezoelectric thin wires arranged on a surface of one of the same were positioned between the sintered piezoelectric thin wires arranged on a surface of the other of the same, and in this state they were integrated, so that a laminated composite sheet unit was formed. More specifically, it was heated at 120°C for one hour while a pressure of 10 kg/cm² was applied to the same from the upper and lower surfaces, so that they were integrated. As a result, a laminated composite sheet

unit 51 as shown in the schematic perspective view of FIG. 19B was obtained. The obtained laminated composite sheet unit approximately was in a size of 17 mm in vertical length \times 17 mm in horizontal length \times 0.100 mm in thickness, and contained 284 ($= 142 \times 2$) sintered piezoelectric thin wires, each having a width of 0.05 mm, a thickness of 0.05 mm, and a length of 17 mm, arranged at uniform intervals of 0.01 mm inside the resin layer 22.

IN THE CLAIMS

Please amend the following claim:

31. (Amended) A method for producing a piezocomposite, comprising the steps of:

- (a) preparing a sintered piezoelectric plate having a thickness ranging from 10 μm to 500 μm ;
- (b) provisionally fixing the sintered piezoelectric plate on a substrate, by using an adhesive sheet;
- (c) forming a plurality of parallel cut grooves in the sintered piezoelectric plate so as to cut the sintered piezoelectric plate into pieces, to obtain a plurality of sintered piezoelectric thin wires;
- (d) transferring the plurality of the sintered piezoelectric thin wires provisionally fixed on the substrate onto a resin sheet;
- (e) repeating the steps (a) to (d) a plurality of times, so as to prepare a plurality of composite sheet units on a surface of each of which a plurality of the sintered piezoelectric thin wires are arranged in a uniform direction;

(f) laminating a plurality of the composite sheet units so that the sintered piezoelectric thin wires are positioned between the resin layers; and

(g) integrating the plurality of the composite sheet units thus laminated.

IN THE DRAWINGS

Please amend the drawings as per the attached drawing sheet and marked-up copy.

REMARKS

The above preliminary amendment is made to make minor editorial corrections to the specification, claims, and drawings.

Applicants respectfully request that the preliminary amendment described herein be entered into the record prior to calculation of the filing fee and prior to examination and consideration of the above-identified application.

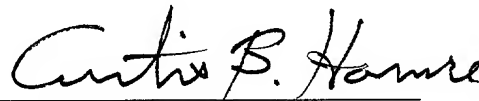
If a telephone conference would be helpful in resolving any issues concerning this communication, please contact Applicants' primary attorney-of record, Douglas P. Mueller (Reg. No. 30,300), at (612) 371.5237.

Respectfully submitted,

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Minneapolis, Minnesota 55402-0903
(612) 332-5300

Dated: January 22, 2002

By



Curtis B. Hamre
Reg. No. 30,300

DPM/tvm

MARKED-UP COPY

IN THE SPECIFICATION

Please amend the following consecutive paragraphs, beginning on page 18, line 6:

As a step of applying a paste containing a piezoelectric powder and a binder to the grooves 11, a paste composed of a piezoelectric powder, a binder, and a solvent was applied over the grooves 11 on the substrate 1 so as to fill the grooves 11, then, unnecessary paste portions 2 outside the grooves 11 were removed. As a result, the substrate 1 in which the paste [2] was applied to only the inside of each groove 11 was obtained, as shown in the schematic perspective view of FIG. 2A and the schematic cross-sectional view of FIG. 2B. Though not particularly limited, a conventional technique of a thick film material can be applied for forming the paste [2]. For instance, a paste obtained by adding 10 cc of an α -terpineol (reagent manufactured by Wako Pure Chemical Industries, Ltd.) solution containing 6 wt% of ethyl cellulose 45 cP (manufactured by Kanto Kagaku) as a binder to 40 g of a piezoelectric powder of lead titanate zirconate (PZT) or the like and kneading the same using a three roll mill can be used. Subsequently, on the groove-provided surface of the groove-provided magnesium oxide plate as the substrate 1, the PZT paste as the paste [2] was applied and squeezed by a rubber squeegee so as to fill the grooves with the PZT paste while removing unnecessary portions of the PZT paste from outside the grooves. Alternatively, to fill the grooves 11 with the paste sufficiently, air bubbles contained therein preferably were removed by depressurizing or vibrating with ultrasonic waves after applying the paste in the grooves 11.

(3) Step of drying the coating films

As a step of drying the coating films, the solvent component was dried and removed from the paste [2] provided in the grooves 11 of the substrate 1. As a method for drying the solvent,

any method may be applied, such as natural drying, hot air drying, etc. Besides, according to a quantity to be treated, the batch manner or the continuous manner may be selected. In the present embodiment, the solvent component in the PZT paste was removed by drying the same at 100°C in a hot air circulating batch-type dryer for 5 minutes.

Please amend the following paragraph, beginning on page 19, line 23:

Subsequently, the heat treatment was continued so that the temperature was raised to 1250°C during 12.5 hours and thereafter it was maintained at 1250°C for two hours, so that the piezoelectric powder was sintered. By so doing, thin-line-form sinter pieces 3 were obtained on the substrate 1. The paste [2] that had been dried and from which the binder had been removed was sintered in the grooves 11 of the substrate 1, thereby forming the thin-line-form sinter pieces 3. The thin-line-form sinter pieces 3 thus obtained were sintered in the state of being constrained and arranged in the grooves 11 formed in the substrate 1. Consequently, as shown in the schematic perspective view of FIG. 3A and the schematic cross-sectional view of FIG. 3B, a plurality of thin-line-form sinter pieces 3 were obtained on the substrate 1, arranged at intervals according to the intervals between the grooves 11 formed in the substrate 1. In the present embodiment, 200 thin-line-form sinter pieces, each having a width and a height of 0.065 mm each and a length of 30 mm, were obtained on the substrate 1. Furthermore, the thin-line-form sinter pieces 3 had a volume reduced to 65 % in average as compared with the volume in the material paste state. It should be noted that the steps (1) to (5) may be carried out at the same time.

Please amend the following paragraph, beginning on page 25, line 26:

Then, a step (c), applied to the sintered piezoelectric plate provided with the resin layer, formed a plurality of parallel cut grooves without completely dividing the resin layer so as to cut the sintered piezoelectric plate into a plurality of sintered piezoelectric thin wires. 170 cut grooves, each having a width of 0.05 mm and a depth of 0.05 mm to 0.06 mm, were formed at intervals of 0.1 mm on the sintered piezoelectric plate having the foregoing resin layer, using a dicing machine. As a result, as shown in the schematic perspective view of FIG. 11, a composite sheet unit 50 was obtained that was composed of a resin layer [2] 22 having a size of 17 mm in vertical length \times 17 mm in horizontal length \times 0.05 mm in thickness and 170 sintered piezoelectric thin wires, each having a width of 0.05 mm, a thickness of 0.05 mm, and a length of 17 mm. 11 denotes a cut groove.

Please amend the following paragraph, beginning on page 34, line 20:

(a) First of all, composite sheet units 50 were obtained by the same method as that described with regard to the fourth embodiment. Namely, each composite sheet unit prepared was a composite sheet unit 50 in which 170 sintered piezoelectric thin wires, each having a width of 0.05 mm, a thickness of 0.05 mm, and a length of 17 mm, were arranged on a resin layer 2 in a size of 17 mm in vertical length \times 17 mm in horizontal length \times 0.05 mm in thickness. Then, as shown in the schematic perspective view of FIG. 18A, an epoxy resin layer in a size of 17 mm in vertical length \times 17 mm in horizontal length \times 0.025 mm in thickness as a resin layer 22, or more specifically, an epoxy-base-resin adhesive sheet (Product No.: T2000 manufactured by Hitachi Chemical Co., Ltd.), in a size of 17 mm in vertical length \times 17 mm in horizontal length \times

0.025 mm in thickness, was laminated over the sintered piezoelectric thin wires [22] 33 arranged on the composite sheet unit 50.

Please amend the following paragraph, beginning on page 36, line 29:

(b) [The foregoing two] Two of the foregoing composite sheet units 50 were provided so that the sintered piezoelectric thin wires arranged on a surface of one of the same were positioned between the sintered piezoelectric thin wires arranged on a surface of the other of the same, and in this state they were integrated, so that a laminated composite sheet unit was formed. More specifically, it was heated at 120°C for one hour while a pressure of 10 kg/cm² was applied to the same from the upper and lower surfaces, so that they were integrated. As a result, a laminated composite sheet unit 51 as shown in the schematic perspective view of FIG. 19B was obtained. The obtained laminated composite sheet unit approximately was in a size of 17 mm in vertical length × 17 mm in horizontal length × 0.100 mm in thickness, and contained 284 (= 142 × 2) sintered piezoelectric thin wires, each having a width of 0.05 mm, a thickness of 0.05 mm, and a length of 17 mm, arranged at uniform intervals of 0.01 mm inside the resin layer 22.

IN THE CLAIMS

Please amend the following claim:

31. (Amended) A method for producing a piezocomposite, comprising the steps of:

(a) preparing a sintered piezoelectric plate having a thickness ranging from 10 μm to 500 μm;

(b) provisionally fixing the sintered piezoelectric plate on a substrate, by using an adhesive sheet;

(c) forming a plurality of parallel cut grooves in the sintered piezoelectric plate so as to cut the sintered piezoelectric plate into pieces, to obtain a plurality of sintered piezoelectric thin wires;

(d) transferring the plurality of the sintered piezoelectric thin wires provisionally fixed on the substrate onto a resin sheet;

(e) repeating the steps (a) to (d) a plurality of times, so as to prepare a plurality of composite sheet units on a surface of each of which a plurality of the sintered piezoelectric thin wires are arranged in a uniform direction;

(f) laminating a plurality of the composite sheet units so that the sintered piezoelectric thin wires are positioned between the resin layers; and

(g) integrating the plurality of the composite sheet units thus laminated.

FIG. 18A

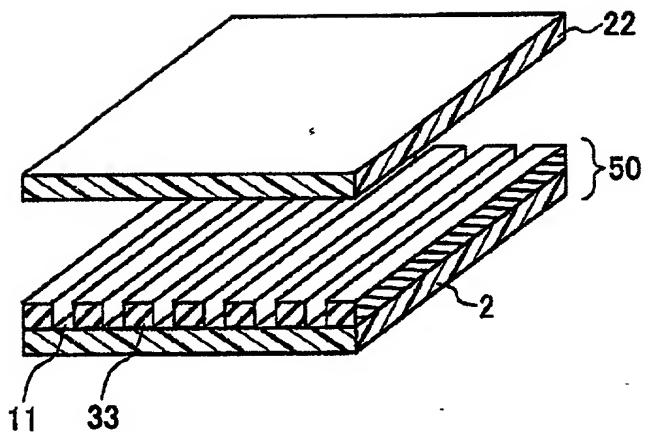


FIG. 18B

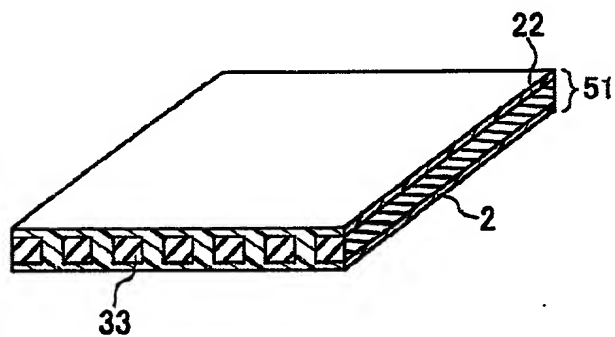
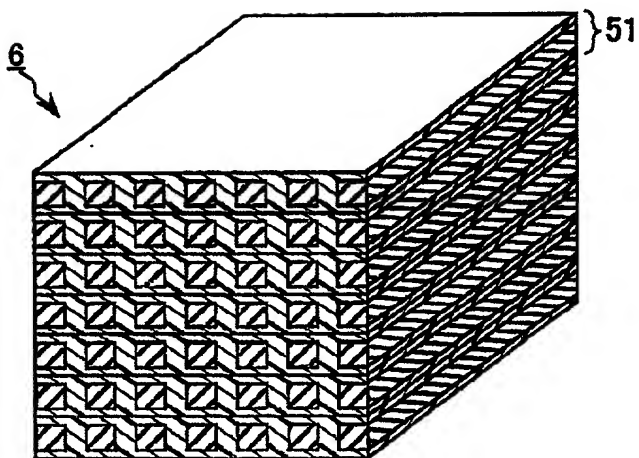


FIG. 18C



MARKED-UP COPY

FIG. 18A

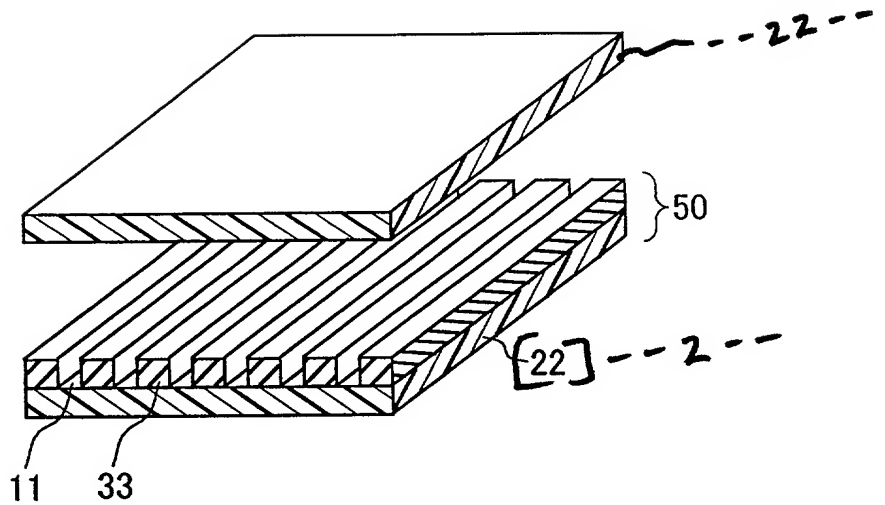


FIG. 18B

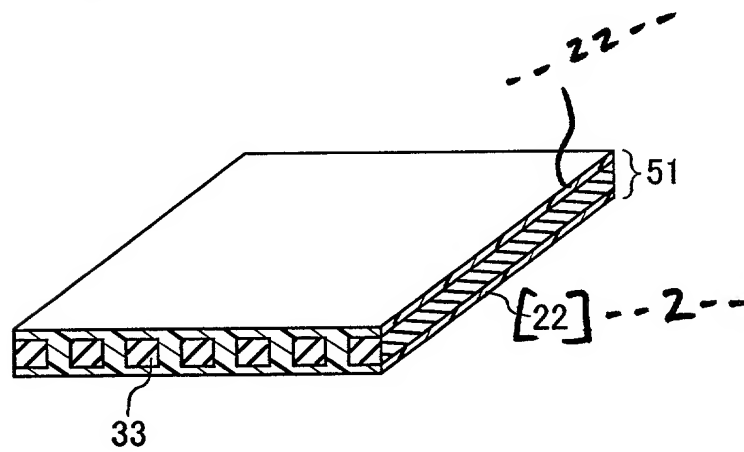


FIG. 18C

